PB-240 229

LAKE CHARLEVOIX, CHARLEVOIX COUNTY, MICHIGAN

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center, Corvallis, Oregon
National Environmental Research Center, Las Vegas, Nevada
Michigan National Guard
Michigan Department of Natural Resources

February 1975

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TECHNICAL REPORT DATA
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1. REPORT NO.	2.	PB 240 229
4. TITLE AND SUBTITLE: Report on Lake Charlevoix, Charlevoix County, Michigan		5. REPORT DATE: Prepared February 1975
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S): Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO.: Working Paper # 188
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Pacific Northwest Environmental Research Laboratory U.S.Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO.: 1BA029 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS: Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460		13. TYPE OF REPORT AND PERIOD COVERED: Final - 1972 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

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INFORMATION SERVICE
U.S Department of Commerce
Springfield, VA. 22151

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
Release unlimited		44
	20. SECURITY CLASS (This page)	22. PRICE
		3.75

EPA Form 2220-1 (9-73)

REPORT

ON

LAKE CHARLEVOIX

CHARLEVOIX COUNTY

MICHIGAN

EPA REGION V

WORKING PAPER No. 188

WITH THE COOPERATION OF THE

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

AND THE

MICHIGAN NATIONAL GUARD

FEBRUARY, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Michigan Department of Natural Resources for professional involvement and to the Michigan National Guard for conducting the tributary sampling phase of the Survey.

A. Gene Gazlay, former Director, and David H. Jenkins, Acting Director, Michigan Department of Natural Resources; and Carlos Fetterolf, Chief Environmental Scientist, and Dennis Tierney, Aquatic Biologist, Bureau of Water Management, Department of Natural Resources, provided invaluable lake documentation and counsel during the course of the Survey. John Vogt, Chief of the Bureau of Environmental Health, Michigan Department of Public Health, and his staff were most helpful in identfying point sources and soliciting municipal participation in the Survey.

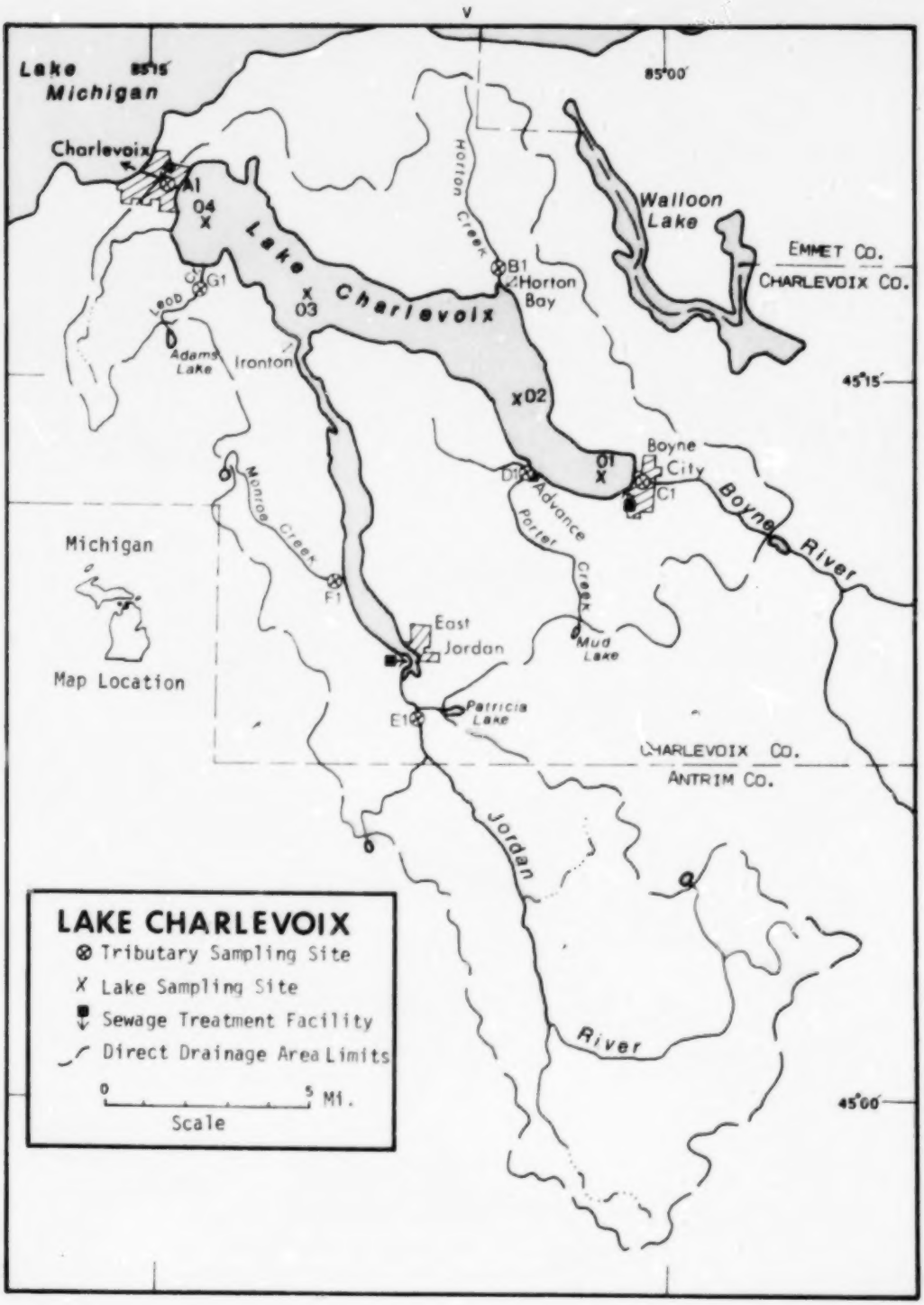
Major General Clarence A. Schnipke (Retired), then the Adjutant General of Michigan, and Project Officer Colonel Albert W. Lesky, who directed the volunteer efforts of the Michigan National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MICHIGAN

LAKE NAME	COUNTY
Allegan Res.	Allegan
Barton	Kalamazoo
Belleville	Wayne
Betsie	Benzie
Brighton	Livingston
Caro Res.	Tuscola
Charlevoix	Charlevoix
Chemung	Livingston
Constantine Res.	St. Joseph
Crystal	Montcalm
Deer	Marquette
Ford	Washtenaw
Fremont	Newago
Higgins	Roscommon
Holloway Res.	Genesee, Lapeer
Houghton	Roscommon
Jordon	Ionia, Barry
Kent	Oakland
Long	St. Joseph
Macatawa	Ottawa
Manistee	Manistee
Mona	Muskegon
Muskegon	Muskegon
Pentwater	Oceana
Pere Marquette	Mason
Portage	Houghton
Randall	Branch
Rogers Pond	Mecosta
Ross	Gladwin
St. Louis Res.	Gratiot
Sanford	Midland
Strawberry	Livingston
Thompson	Livingston
Thornapple	Barry
Union	Branch
White	Muskegon


Lake Michigan
85°15'
85°00'
Charlevoix
A1
04
Lake Charlevoix
03
02
01
Horton Creek
B1
Horton Bay
Walloon Lake
EMMET CO.
CHARLEVOIX CO.
45°15'
G1
Adams Lake
Ironton
Boyne City
C1
Boyne River
Advance
Ferret Creek
Mud Lake
Monroe Creek
F1
East Jordan
E1
Patricia Lake
CHARLEVOIX CO.
ANTRIM CO.
Jordan River
45°00'
Michigan
Map Location
LAKE CHARLEVOIX
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Limits
0
5 Mi.
Scale

LAKE CHARLEVOIX

STORET NO. 2617

I. CONCLUSIONS

A. Trophic Condition:

On the basis of Survey data, it is concluded that Lake Charlevoix is oligotrophic. Of the 35 Michigan lakes sampled in November when essentially all were well-mixed, only one (Higgins Lake) had better overall water quality. Only five lakes had less mean inorganic nitrogen, only three lakes had less mean chlorophyll a, only one lake had greater Secchi disc transparency, three lakes had the same low algal assay control yield (but none were lower), and only one lake had less mean total and dissolved phosphorus*.

Some depression of oxygen (to about 6 mg/l) with depth (below 35 feet) was noted at stations 3 and 4 in September, 1972.

B. Rate-Limiting Nutrient:

The algal assay results and the lake data show that Lake Charlevoix is phosphorus limited.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Lake Charlevoix received a total phosphorus load at a rate less than that proposed by Vollenweider (in press) as "permissible"; i.e.,

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* See Appendix A.

less than an oligotrophic rate (see page 14). Of this load, the Boyne City wastewater treatment plant contributed about 14%.

While the present phosphorus loading rate is relatively low, and 80% phosphorus removal is required at the only known point source impacting the lake (Boyne City), every effort should be made to reduce all phosphorus inputs to the lowest practicable level to ensure that the existing high quality of Lake Charlevoix is maintained.

2. Non-point sources (see page 14)--Attention is called to the non-point phosphorus export rate of the Jordan River. During the sampling year, the rate of P-export of this stream markedly exceeded the non-point phosphorus rates of any of the other five streams sampled. As far as is known, there are no point sources in the Jordan River drainage, and it seems unlikely that the geological characteristics of the drainage would differ much from adjacent drainages. It appears it would be desirable to review the cultural practices in the Jordan River drainage basin in more detail than was possible in this Survey, particularly since the south arm of the lake is much shallower than the main body (Tierney, 1974) and is more susceptible to nutrient inputs.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 17,260 acres.
2. Mean depth: 55 feet.
3. Maximum depth: 122 feet.
4. Volume: 949,300 acre-feet.
5. Mean hydraulic retention time: 3.2 years.

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Horton Creek	11.8 mi^2	18.9 cfs
Boyne River	69.9 mi^2	119.2 cfs
Porter Creek	17.4 mi^2	18.6 cfs
Jordan River	78.2 mi^2	188.5 cfs
Monroe Creek	9.7 mi^2	10.5 cfs
Loeb Creek	5.7 mi^2	5.8 cfs
Minor tributaries & immediate drainage -	110.3 mi^2	43.2 cfs
Totals	303.0 mi^2	404.7 cfs

2. Outlet -

Round Lake inlet	330.0 mi^2**	404.7 cfs

C. Precipitation***:

1. Year of sampling: 36.8 inches.
2. Mean annual: 37.8 inches.

† MI Dept. Cons. lake inventory map (1959); mean depth recalculated by random-dot method.

* Drainage areas are accurate within ±5%; mean daily flows for 74% of the sampling sites are accurate within ±25% and the remaining sites up to ±40%; and mean monthly flows, normalized mean monthly flows, and mean annual flows are slightly more accurate than mean daily flows.

** Includes area of lake.

*** See Working Paper No. 1, "Survey Methods, 1972".

III. LAKE WATER QUALITY SUMMARY

Lake Charlevoix was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from four stations on the lake and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (15 feet to surface) sample was composited from the four stations for phytoplankton identification and enumeration; and during the second visit, a single five-gallon depth-integrated sample was composited for algal assay. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analyses. The maximum depths sampled were 42 feet at station 1, 85 feet at station 2, 100 feet at station 3, and 71 feet at station 4.

The results obtained are presented in full in Appendix C, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix C.

A. Physical and chemical characteristics:

Parameter	Mimimum	Mean	Median	Maximum
		FALL VALUES (11/12/72)		
Temperature (Cent.)	7.7	7.9	7.9	8.1
Dissolved oxygen (mg/l)	10.8	10.9	10.9	11.4
Conductivity (μmhos)	290	305	300	325
pH (units)	7.9	7.9	7.9	8.0
Alkalinity (mg/l)	121	130	130	143
Total P (mg/l)	0.007	0.007	0.007	0.009
Dissolved P (mg/l)	0.004	0.006	0.005	0.009
NO_2 + NO_3 (mg/l)	0.170	0.189	0.180	0.230
Ammonia (mg/l)	0.030	0.041	0.040	0.070
		ALL VALUES		
Secchi disc (inches)	115	149	144	174

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/16/72	1. Dinobryon	1,284
	2. Anabaena	922
	3. Synedra	362
	4. Cyclotella	344
	5. Fragilaria	325
	Other genera	814
	Total	4,051
09/14/72	1. Dinobryon	502
	2. Flagellates	221
	3. Melosira	201
	4. Polycystis	116
	Other genera	356
	Total	1,396
11/12/72	1. Lyngbya	99
	2. Dinobryon	85
	3. Fragilaria	72
	4. Asterionella	54
	5. Synedra	20
	Other genera	108
	Total	438

2. Chlorophyll *a* -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
06/16/72	01	3.9
	02	4.8
	03	3.3
	04	3.5
09/14/72	01	4.7
	02	2.1
	03	2.0
	04	2.2
11/12/72	01	2.9
	02	2.3
	03	2.6
	04	1.8

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.001	0.235	0.1
0.010 P	0.011	0.235	2.3
0.020 P	0.021	0.235	4.5
0.050 P	0.051	0.235	4.8
0.050 P + 5.0 N	0.051	5.235	17.8
0.050 P + 10.0 N	0.051	10.235	20.1
10.0 N	0.001	10.235	0.1

2. Discussion -

The control yield of the assay alga, *Selenastrum capricornutum*, indicates that the potential primary productivity of Charlevoix Lake was low at the time the assay sample was

collected. Also, the increasing yields with increasing increments of orthophosphorus (to about 0.020 mg/l) show that the lake was phosphorus limited at that time. Note that the addition of only nitrogen resulted in a yield no greater than the control yield.

The conclusion of phosphorus limitation is supported by the lake data. Nitrogen to phosphorus ratios were greater than 35 to 1 at all sampling times.

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings the Michigan National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May when two samples were collected. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Michigan District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the means of the nutrient loads, in lbs/mi^2/year, at stations B-1, D-1, E-1, F-1, and G-1 and multiplying the means by the ZZ area in mi^2.

The operator of the Boyne City wastewater treatment plant provided monthly effluent samples and corresponding flow data. The effluent from the East Jordan stabilization pond is disposed of on land with no discharge to Lake Charlevoix.

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* See Working Paper No. 1.

A. Waste Sources:

1. Municipal* -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Boyne City	2,700	primary + P-removal	0.580	Lake Charlevoix
East Jordan	1,600	pond	0.160**	land disposal

2. Industrial - None known

* Anonymous, 1972; Burda, 1973.
** Estimated at 100 gal/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Horton Creek	330	1.7
Boyne River	2,890	15.3
Porter Creek	450	2.4
Jordan River	5,140	27.2
Monroe Creek	290	1.5
Loeb Creek	130	0.7
b. Minor tributaries & immediate drainage (non-point load) -	3,820	20.2
c. Municipal STP's -		
Boyne City	2,670	14.1
d. Septic tanks* -	510	2.7
e. Industrial - None known	-	-
f. Direct precipitation** -	2,690	14.2
Total	18,920	100.0

2. Outputs -

Lake outlet - Round Lake inlet 6,920

3. Net annual P accumulation - 12,000 pounds

* Estimated 810 seasonal dwellings and 1 park on lakeshore; see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Horton Creek	72,660	5.0
Boyne River	204,460	14.1
Porter Creek	52,720	3.6
Jordan River	446,740	30.8
Monroe Creek	21,750	1.5
Loeb Creek	14,990	1.0
b. Minor tributaries & immediate drainage (non-point load) -	436,190	30.0
c. Municipal STP's -		
Boyne City	17,810	1.2
d. Septic tanks* -	19,110	1.3
e. Industrial - None known	-	-
f. Direct precipitation** -	166,280	11.5
Total	1,452,710	100.0

2. Outputs -

Lake outlet - Round Lake inlet 759,320

3. Net annual N accumulation - 693,390 pounds

* Estimated 810 seasonal dwellings and 1 park on lakeshore; see Working Paper No. 1.
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs $P/mi^2/yr$	lbs $N/mi^2/yr$
Horton Creek	28	6,158
Boyne River	41	2,925
Porter Creek	26	3,030
Jordan River	66	5,713
Monroe Creek	30	2,242
Loeb Creek	23	2,630

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving water would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	1.1	0.7	82.2	40.2
grams/m^2/yr	0.12	0.08	9.4	4.5

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Charlevoix:

"Dangerous" (eutrophic rate)	0.44
"Permissible" (oligotrophic rate)	0.22

V. LITERATURE REVIEWED

Anonymous, 1972. Treatment plant questionnaire (Boyne City). MI Dept. Public Health, Lansing.

Burda, Kenneth, 1973. Treatment plant questionnaires (East Jordan and Charlevoix). MI Dept. Nat. Resources, Lansing.

Tierney, Dennis, 1974. Personal communication (review of preliminary report on Lake Charlevoix). MI Dept. Nat. Resources, Lansing.

Vollenweider, Richard A. (in press). Input-output models. Schweiz. Z. Hydrol.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	ALL VALUES MEAN TOTAL P	ALL VALUES MEAN DISS P	ALL VALUES MEAN INORG N	ALL VALUES 500- MEAN SEC	ALL VALUES MEAN CHLORA	ALL VALUES 15- MIN DO
2640	MULLOWAY RESERVOIR	0.062	0.043	1.461	439.375	10.670	9.200
2641	CARO RESERVOIR	0.117	0.022	3.835	473.000	11.967	9.500
2642	BOARDMAN HYDRO POND	0.006	0.005	0.358	383.500	1.267	9.500
2603	ALLEGAN LAKE	0.123	0.057	1.168	478.222	20.311	12.600
2606	BARTON LAKE	0.121	0.046	1.489	456.167	27.800	14.850
2609	BELLEVILLE LAKE	0.118	0.048	1.420	485.250	28.262	8.200
2610	BETSIE LAKE	0.025	0.008	0.273	481.667	4.567	7.400
2613	BRIGHTON LAKE	0.109	0.073	1.015	456.000	44.233	7.500
2617	LAKE CHARLEVOIX	0.007	0.006	0.230	351.250	3.008	9.240
2618	LAKE CHEMUNG	0.046	0.014	0.132	404.333	13.483	14.800
2621	CONSTANTINE RESERVOIR	0.027	0.008	0.410	456.167	39.317	7.500
2629	FORD LAKE	0.105	0.058	1.536	456.167	14.733	14.000
2631	FREMONT LAKE	0.372	0.342	1.406	441.667	28.500	14.800
2640	JORDAN LAKE	0.180	0.144	1.998	427.667	20.517	14.900
2643	KENT LAKE	0.040	0.015	0.417	455.000	33.966	13.000
2648	LAKE MACATAWA	0.197	0.120	2.358	477.600	25.600	12.200
2649	MANISTEE LAKE	0.018	0.010	0.304	451.333	6.317	11.360
2659	MUSKEGON LAKE	0.047	0.043	0.469	436.444	9.511	14.800
2665	PENTWATER LAKE	0.027	0.017	0.496	438.667	10.083	14.800
2671	RANDALL LAKE	0.246	0.183	0.816	457.333	27.217	8.020
2672	ROGERS POND	0.020	0.015	0.183	435.500	8.133	9.600
2673	RUSS RESERVOIR	0.034	0.021	0.460	465.333	10.383	8.200
2674	SANFORD LAKE	0.016	0.008	0.387	458.750	13.791	8.300
2683	THORNAPPLE LAKE	0.042	0.032	1.737	442.833	14.650	10.800
2685	UNION LAKE	0.083	0.064	1.252	455.500	15.667	8.200
2688	WHITE LAKE	0.027	0.019	0.367	417.778	9.211	13.400
2691	MUNA LAKE	0.307	0.241	0.963	451.667	27.783	14.100
2692	LONG LAKE	0.163	0.148	0.749	418.400	10.067	13.600

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES MEAN TOTAL P	FALL VALUES MEAN DISS P	FALL VALUES MEAN INORG N	ALL VALUES 500- MEAN SEC	ALL VALUES MEAN CHLORA	ALL VALUES 15- MIN DO
2693	ST LOUIS RESERVOIR	0.134	0.093	1.227	462.667	5.583	8.420
2694	CRYSTAL LAKE	0.009	0.006	0.164	380.000	2.986	13.000
2695	HIGGINS LAKE	0.007	0.005	0.058	268.500	1.043	9.400
2696	HOUGHTON LAKE	0.018	0.008	0.136	420.833	9.217	8.200
2697	THOMPSON LAKE	0.043	0.024	0.436	407.889	11.967	14.800
2698	PERE MARQUETTE LAKE	0.032	0.024	0.346	448.667	11.833	8.600
2699	STRAWBERRY LAKE	0.069	0.050	0.567	419.800	11.117	13.600

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: SDD-MEAN SEC	ALL VALUES: MEAN CHLOA	ALL VALUES: IS-MIN DO	INDEX NO
2680	HOLLOWAY RESERVOIR	46 (16)	43 (15)	17 (6)	57 (20)	60 (21)	63 (22)	286
2681	CARO RESERVOIR	29 (10)	54 (19)	0 (0)	3 (1)	49 (17)	54 (19)	189
2682	BOARDMAN HYDRO POND	97 (34)	97 (34)	69 (24)	91 (32)	94 (33)	97 (34)	545
2683	ALLEGAN LAKE	20 (7)	31 (11)	31 (11)	6 (2)	29 (10)	40 (14)	157
2686	BANTON LAKE	23 (8)	20 (7)	14 (5)	29 (9)	14 (5)	3 (1)	103
2689	BELLEVILLE LAKE	26 (9)	37 (13)	20 (7)	11 (4)	11 (4)	79 (26)	184
2690	BETSIE LAKE	77 (27)	77 (27)	80 (28)	17 (6)	86 (30)	94 (33)	431
2693	BRIGHTON LAKE	31 (11)	23 (8)	34 (12)	34 (12)	0 (0)	90 (31)	212
2697	LAKE CHARLEVOIX	91 (32)	91 (32)	83 (29)	94 (33)	89 (31)	60 (21)	508
2698	LAKE CHEMUNG	49 (17)	71 (25)	94 (33)	86 (30)	46 (16)	11 (2)	357
2701	CONSTANTINE RESERVOIR	71 (25)	83 (29)	40 (14)	29 (9)	3 (1)	90 (31)	316
2709	FORD LAKE	34 (12)	29 (10)	11 (4)	29 (9)	37 (13)	23 (8)	163
2711	FREMONT LAKE	0 (0)	0 (0)	23 (8)	54 (19)	9 (3)	11 (2)	97
2720	JORDAN LAKE	11 (4)	11 (4)	6 (2)	69 (24)	26 (9)	0 (0)	123
2723	KENT LAKE	57 (20)	69 (24)	63 (22)	40 (14)	6 (2)	36 (12)	271
2728	LAKE MACATAWA	9 (3)	14 (5)	3 (1)	0 (0)	23 (8)	43 (15)	92
2729	MANISTEE LAKE	80 (28)	74 (26)	77 (27)	46 (16)	80 (28)	46 (16)	403
2739	MUSKEGON LAKE	37 (13)	40 (14)	54 (19)	60 (21)	69 (24)	11 (2)	271
2745	PENTWATER LAKE	69 (24)	63 (22)	51 (18)	66 (23)	31 (11)	11 (2)	291
2751	RANDALL LAKE	6 (2)	6 (2)	43 (15)	23 (8)	20 (7)	86 (30)	184
2752	ROGERS POND	74 (26)	66 (23)	86 (30)	63 (22)	77 (27)	51 (18)	417
2753	RUSS RESERVOIR	60 (21)	57 (20)	57 (20)	9 (3)	63 (22)	74 (26)	325
2754	SANFORD LAKE	86 (30)	80 (28)	74 (26)	20 (7)	43 (15)	71 (25)	374
2763	THORNAPPLE LAKE	54 (19)	46 (16)	9 (3)	51 (18)	40 (14)	49 (17)	249
2765	UNION LAKE	40 (14)	26 (9)	26 (9)	37 (13)	34 (12)	79 (26)	242
2768	WHITE LAKE	66 (23)	60 (21)	66 (23)	80 (28)	74 (26)	31 (11)	377
2791	MONA LAKE	3 (1)	3 (1)	37 (13)	43 (15)	17 (6)	20 (7)	123
2792	LONG LAKE	14 (5)	9 (3)	46 (16)	77 (27)	66 (23)	27 (9)	239

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500-MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 15-MIN DO	INDEX NO
2693	ST LOUIS RESERVOIR	17 (6)	17 (6)	29 (10)	14 (5)	83 (29)	69 (24)	229
2694	CRYSTAL LAKE	89 (31)	89 (31)	89 (31)	89 (31)	91 (32)	36 (12)	483
2695	HIGGINS LAKE	94 (33)	94 (33)	97 (34)	97 (34)	97 (34)	57 (20)	536
2696	HOUGHTON LAKE	83 (29)	86 (30)	91 (32)	71 (25)	71 (25)	79 (26)	481
2697	THOMPSON LAKE	51 (18)	49 (17)	60 (21)	83 (29)	51 (18)	11 (2)	305
2698	PERE MARQUETTE LAKE	63 (22)	51 (18)	71 (25)	49 (17)	54 (19)	66 (23)	354
2699	STRAWBERRY LAKE	43 (15)	34 (12)	49 (17)	74 (26)	57 (20)	27 (9)	284

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2617 CHARLEVOIX LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 330.00

TRIBUTARY	SUB-DRAINAGE AREA(SQ MI)	NORMALIZED FLOWS(CFS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2617A1	330.00	376.00	374.00	410.00	496.00	420.00	405.00	384.00	374.00	400.00	395.00	420.00	403.00	404.72
2617B1	11.80	17.60	17.50	19.00	23.00	19.60	19.00	17.80	17.50	18.70	18.50	19.60	18.80	18.88
2617C1	69.90	111.00	110.00	121.00	146.00	123.00	119.00	113.00	110.00	118.00	116.00	124.00	119.00	119.16
2617D1	17.40	17.20	17.10	18.80	22.80	19.30	18.70	17.80	17.10	18.40	18.20	19.30	18.30	18.58
2617E1	78.20	175.00	174.00	191.00	231.00	196.00	189.00	179.00	174.00	186.00	184.00	195.00	188.00	188.49
2617F1	9.73	9.80	9.80	10.60	13.00	11.00	10.60	10.00	9.80	10.50	10.30	11.00	10.60	10.58
2617G1	5.69	5.40	5.30	5.80	7.10	6.00	5.60	5.50	5.30	5.70	5.60	6.00	5.80	5.76
2617Z2	137.00	40.00	40.00	44.00	53.00	45.00	43.60	41.00	40.00	43.00	42.00	45.00	43.00	43.25

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 330.00
SUM OF SUB-DRAINAGE AREAS = 329.72

TOTAL FLOW IN = 4856.66
TOTAL FLOW OUT = 4857.00

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2617A1	10	72	417.00	29	410.00				
	11	72	422.00	21	407.00				
	12	72	437.00	20	426.00				
	1	73	432.00	20	517.00				
	2	73	379.00	24	373.00				
	3	73	457.00	24	414.00				
	4	73	429.00	7	420.00	21	479.00		
	5	73	424.00	5	426.00	19	407.00		
	6	73	417.00	22	368.00				
	7	73	377.00	25	367.00				
	8	73	368.00	23	371.00				
	9	73	384.00	8	355.00	15	362.00		
2617B1	10	72	20.00	29	19.00				
	11	72	20.00	21	19.00				
	12	72	20.00	20	20.00				
	1	73	20.00	20	24.00				
	2	73	18.00	24	18.00				
	3	73	21.00	24	19.00				
	4	73	20.00	7	20.00	21	22.00		
	5	73	20.00	5	20.00	19	19.00		
	6	73	20.00	22	17.00				
	7	73	18.00	25	17.00				
	8	73	17.00	23	17.00				
	9	73	18.00	8	17.00	15	17.00		

LAKE CODE 2617 CHARLEVOIX LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2617C1	10	72	122.00	29	120.00				
	11	72	125.00	21	120.00				
	12	72	129.00	20	126.00				
	1	73	128.00	20	153.00				
	2	73	112.00	24	110.00				
	3	73	135.00	24	122.00				
	4	73	127.00	7	124.00	21	142.00		
	5	73	124.00	5	122.00	19	118.00		
	6	73	122.00	22	108.00				
	7	73	112.00	25	109.00				
	8	73	109.00	23	110.00				
	9	73	114.00	8	105.00	15	107.00		
2617D1	10	72	19.00	29	19.00				
	11	72	19.00	21	19.00				
	12	72	20.00	20	19.00				
	1	73	20.00	20	24.00				
	2	73	17.00	24	17.00				
	3	73	21.00	24	19.00				
	4	73	20.00	7	19.00	21	22.00		
	5	73	19.00	5	19.00	19	19.00		
	6	73	19.00	22	17.00				
	7	73	17.00	25	17.00				
	8	73	17.00	23	17.00				
	9	73	18.00	8	16.00	15	17.00		
2617E1	10	72	194.00	29	191.00				
	11	72	196.00	21	189.00				
	12	72	203.00	20	198.00				
	1	73	201.00	20	240.00				
	2	73	176.00	24	173.00				
	3	73	213.00	24	193.00				
	4	73	199.00	7	195.00	21	222.00		
	5	73	199.00	5	197.00	19	190.00		
	6	73	194.00	22	172.00				
	7	73	175.00	25	170.00				
	8	73	171.00	23	172.00				
	9	73	178.00	8	165.00	15	167.00		
2617F1	10	72	11.00	29	11.00				
	11	72	11.00	21	11.00				
	12	72	12.00	20	11.00				
	1	73	11.00	20	13.00				
	2	73	10.00	24	9.90				
	3	73	12.00	24	11.00				
	4	73	11.00	7	11.00	21	13.00		
	5	73	11.00	5	11.00	19	11.00		
	6	73	11.00	22	9.60				
	7	73	9.80	25	9.50				
	8	73	9.70	23	9.80				
	9	73	10.00	8	9.40	15	9.50		

LAKE CODE 2617 CHARLEVOIX LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
261761	10	72	5.90	29	5.80				
	11	72	6.00	21	5.70				
	12	72	6.40	20	6.20				
	1	73	6.30	20	7.50				
	2	73	5.40	24	5.30				
	3	73	6.40	24	5.80				
	4	73	6.00	7	5.90	21	6.80		
	5	73	6.00	5	5.90	19	5.70		
	6	73	5.70	22	5.10				
	7	73	5.30	25	5.20				
	8	73	5.20	23	5.20				
	9	73	5.40	8	5.00	15	5.10		
261722	10	72	45.00						
	11	72	45.00						
	12	72	47.00						
	1	73	46.00						
	2	73	41.00						
	3	73	49.00						
	4	73	46.00						
	5	73	45.00						
	6	73	45.00						
	7	73	40.00						
	8	73	39.00						
	9	73	41.00						

APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/02/04

2617U1
42 12 54.0 085 02 06.0
LAKE CHARLEVOIX
26 MICHIGAN

11EMALES
J

2111202
0040 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/16	12 05	0000	13.1	11.2	144	300	8.51	150	0.120	0.030	0.004	0.003
	12 05	0015	13.4	10.4		280	8.58	150	0.140	0.030	0.004	0.004
	12 05	0030	13.2	10.8		280	8.62	148	0.130	0.030	0.005	0.003
72/09/14	13 30	0000			115	273	8.45	120	0.090	0.030	0.007	0.006
	13 30	0004	19.4			261	8.45	129	0.090	0.020	0.008	0.004
	13 30	0015	19.2			260	8.45	120	0.090	0.020	0.006	0.003
	13 30	0020	19.1	9.5		260	8.45	121	0.090	0.020	0.006	0.003
	13 30	0030	19.1	9.4		261	8.45	122	0.080	0.020	0.005	0.003
	13 30	0040	19.0	9.3		265	8.45	122	0.090	0.020	0.006	0.004
72/11/12	10 50	0000			173	325	7.90	128	0.180	0.030	0.007	0.005
	10 50	0004	7.8	10.8		315	7.90	127	0.180	0.030	0.008	0.005
	10 50	0015	7.8	11.0		310	7.90	129	0.180	0.030	0.008	0.005
	10 50	0030	7.8	10.9		310	7.90	130	0.180	0.040	0.008	0.005
	10 50	0042	7.8	11.0		310	7.90	130	0.180	0.030	0.008	0.004

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/16	12 05	0000	3.9J
72/09/14	13 30	0000	4.7J
72/11/12	10 50	0000	2.9J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE: 75/02/04

2617U2
45 14 30.0 085 04 42.0
LAKE CHARLEVOIX
26 MICHIGAN

11EPALES
3

2111202
0090 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/16	12	40 0000	12.6	10.4	144	280	8.04	148	0.120	0.020	0.004	0.004
	12	40 0030	12.3	11.6		280	8.05	149	0.130	0.040	0.004	0.003
	12	40 0040	6.1	11.8				150	0.190	0.050	0.004	0.004
	12	40 0060	4.0	11.2		295	8.21	152	0.210	0.060	0.004	0.002
72/09/14	14	14 0000			171	265	8.45	127	0.100	0.030	0.005	0.005
	14	14 0004	10.3	7.9		260	8.50	127	0.100	0.030	0.006	0.004
	14	14 0015	10.2	7.2		260	8.50	126	0.100	0.030	0.005	0.003
	14	14 0025	10.2	8.6		270	8.10	126	0.100	0.030	0.005	0.004
	14	14 0045	7.8	10.0		270	8.16	124	0.180	0.040	0.005	0.004
	14	14 0065	8.2	7.1		285	7.80	130	0.310	0.020	0.005	0.005
	14	14 0085	7.8	8.6		290	7.80	132	0.320	0.030	0.006	0.005
72/11/12	11	20 0000			174	310	7.90	125	0.180	0.030	0.007	0.005
	11	20 0004	8.1	10.8		310	7.90	143	0.180	0.030	0.007	0.005
	11	20 0015	8.1	10.8		310	7.90	123	0.180	0.030	0.007	0.006
	11	20 0025	8.1									
	11	20 0035	8.1	10.8		335	7.90	132	0.170	0.050	0.009	0.009
	11	20 0045	8.1									
	11	20 0055	8.1	10.8		300	7.90	134	0.180	0.040	0.007	0.005
	11	20 0065	8.1									
	11	20 0075	7.8	10.8		325	7.90	140	0.180	0.040	0.009	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/16	12	40 0000	4.8J
72/09/14	14	14 0000	2.1J
72/11/12	11	20 0000	2.3J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 75/02/04

261703
45 16 48.0 085 10 48.0
LAKE CHARLEVOIX
26 MICHIGAN

11EPALES
3

2111202
0100 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/16	14 50	0000	11.5	10.4	120	265	8.08	149	0.140	0.020	0.005	0.003
	14 50	0015	12.7	10.6		280	8.32	147	0.150	0.040	0.004	0.003
	14 50	0030	8.5	10.8		280	8.24	147	0.160	0.040	0.004	0.003
	14 50	0050	4.4	11.8		290	8.00	149	0.200	0.040	0.004	0.002
	14 50	0080	3.3	11.6		290	7.91	151	0.220	0.060	0.005	0.003
72/09/14	15 00	0000			163	270	8.40	122	0.110	0.060	0.005	0.005
	15 00	0004	18.6	9.2		265	8.45	122	0.100	0.040	0.005	0.003
	15 00	0015	18.5	9.2		260	8.45	112	0.100	0.080	0.005	0.004
	15 00	0035	16.8	7.0		265	8.00	129	0.180	0.050	0.005	0.004
	15 00	0055	9.4	7.0		275	7.80	128	0.280	0.040	0.007	0.005
	15 00	0075	7.3	6.6		281	7.80	130	0.300	0.060	0.007	0.007
	15 00	0100	6.8	6.2		290	7.75	138	0.320	0.030	0.079	0.004
72/11/12	13 40	0000			144	306	8.00	130	0.230	0.070	0.007	0.006
	13 40	0004	7.9	10.9		295	8.00	128	0.220	0.060	0.008	0.007
	13 40	0015	7.9	10.9		295	8.00	128	0.190	0.040	0.007	0.008
	13 40	0025	7.9									
	13 40	0035	7.9	10.9			8.00					
	13 40	0045	7.9			290		128	0.180	0.040	0.007	0.006
	13 40	0055	7.9									
	13 40	0065	7.9	10.9			8.00					
	13 40	0075	7.9			300		127	0.190	0.050	0.007	0.005
	13 40	0085	7.9									
	13 40	0095	7.9	10.9			8.00					
	13 40	0100	7.7			300		121	0.200	0.030	0.007	0.005

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/16	14 50	0000	3.3J
72/09/14	15 00	0000	2.6J
72/11/12	13 40	0000	2.6J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 75/02/04

261704
45 18 30.0 085 13 36.0
LAKE CHARLEVOIX
26 MICHIGAN

11EPALES
3

2111202
0070 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/16	16 35	0000	11.4	11.2	144	240	8.42	147	0.160	0.040	0.003	0.002K
	16 35	0015	10.5	11.0		570	8.50	147	0.150	0.020	0.004	0.002
	16 35	0030	7.2	12.0				147	0.200	0.030	0.005	0.005
	16 35	0070	3.7	13.0		275	8.18	150	0.220	0.060	0.005	0.004
72/09/14	18 10	0000			108	260	8.45	122	0.110	0.030	0.004	0.004
	18 10	0004	18.2	9.3		261	8.40	122	0.110	0.030	0.005	0.003
	18 10	0015	18.2	9.4		260	8.45	122	0.110	0.030	0.004	0.003
	18 10	0025	17.5	9.1		261	8.40	122	0.110	0.030	0.005	0.004
	18 10	0035	12.4	8.8		274	7.90	129	0.240	0.030	0.006	0.003
	18 10	0045	10.3	8.9		280	7.80	132	0.270	0.030	0.006	0.007
	18 10	0055	9.8	8.8		285	7.80	131	0.290	0.030	0.005	0.003
	18 10	0065	7.9	9.8		295	7.70	132	0.300	0.040	0.006	0.004
72/11/12	13 05	0000			125	305	8.00	131	0.180	0.040	0.007	0.005
	13 05	0004	7.8	11.0		300	8.00	132	0.180	0.040	0.007	0.005
	13 05	0015	7.8	11.1		300	8.00	132	0.180	0.040	0.008	0.005
	13 05	0025	7.8	11.2		290		132	0.180	0.030	0.007	0.005
	13 05	0035	7.8									
	13 05	0045	7.7	11.1		300	8.00	133	0.220	0.060	0.008	0.005
	13 05	0055	7.7									
	13 05	0065	7.7									
	13 05	0071	7.7	11.4		300	8.00	130	0.220	0.060	0.007	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/16	16 35	0000	3.3J
72/09/14	18 10	0000	2.2J
72/11/12	13 05	0000	1.5J

J VALUE KNOWN TO BE IN ERROR

APPENDIX D

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/02/04

261741 L5261741
45 19 00.0 085 15 00.0
LAKE CHARLEVOIX/ROUND LK CONNECT
26 15 BAYSHORE
C/LAKE CHARLEVOIX
MI BRDG ABOVE CHARLEVOIX STP
11EPALES 21112U4
" 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/29	12 00		0.240	0.200	0.056	0.005K	0.006
72/11/21	12 15		0.182	2.310	0.077	0.008	0.011
72/12/20	11 30		0.198	1.940	0.098	0.005K	0.008
73/01/20	11 30		0.210	0.180	0.016	0.005K	0.005K
73/02/24	11 05		0.189	0.240	0.017	0.005K	0.010
73/03/24	11 00		0.230	0.170	0.005K	0.005K	0.005K
73/04/07	11 00		0.220	1.470	0.048	0.006	0.010
73/04/21	11 30		0.220	0.170	0.015	0.006	0.010
73/05/05	11 00		0.180	0.390	0.023	0.005K	0.013
73/05/19	11 15		0.198	1.050	0.029	0.006	0.010
73/06/22	11 45		0.160	0.280	0.039	0.005K	0.010
73/07/25	11 30		0.125	0.240	0.022	0.010	0.010
73/08/23	11 30		0.092	0.420	0.030	0.005K	0.010
73/09/15	12 30		0.105	0.600	0.014	0.006	0.008

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

20170I L3261701
45 17 30.0 045 05 00.0
HURON CREEK
26 15 BAYSHORE
17LAKE CHARLEVOIX
ROAD XING NW OF HURON BAY
11EMALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/24	10 30		0.250	0.450	0.054	0.005K	0.005K
72/11/21	11 30		1.500	0.480	0.022	0.005K	0.005K
73/01/20	11 00		1.040	0.457	0.023	0.005K	0.010
73/02/24	10 40		1.560	0.150	0.019	0.005K	0.010
73/03/24	10 30		1.440	0.170	0.010	0.005K	0.005K
73/04/07	10 35		1.420	0.370	0.022	0.005K	0.010
73/04/21	10 45		1.240	0.450	0.014	0.005K	0.027
73/05/05	10 30		1.390	0.210	0.010	0.005K	0.005K
73/05/19	10 45		1.320	1.340	0.032	0.005K	0.005K
73/06/22	10 45		1.300	0.230	0.024	0.005K	0.005K
73/07/25	10 45		0.710	3.000	0.378	0.007	0.007
73/08/23	11 00		1.260	1.500	0.030	0.006	0.015
73/09/15	11 00		1.360	0.450	0.012	0.005K	0.005K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

251/C1 E5261/C1
45 13 00.0 085 01 00.0
BOYNE RIVER
26 15 BOYNE CITY
1/LAKE CHARLEVOIX
LK ST BRDG IN BOYNE CITY
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/24	10	10	0.350	0.550	0.054	0.005K	0.007
72/11/21	10	45	0.440		0.297	0.006	0.015
72/12/20	10	30	0.450		0.220	0.006	0.015
73/01/20	10	30	0.310	0.360	0.021	0.005K	0.010
73/02/24	10	30	0.450	0.340	0.023	0.005K	0.015
73/03/24	10	15	0.430	0.150	0.009	0.005K	0.010
73/04/07	10	20	0.399	0.480	0.048	0.007	0.015
73/04/21	10	20	0.380	0.460	0.053	0.009	0.010
73/05/05	10	15	0.370	0.490	0.034	0.005K	0.015
73/05/19	10	30	0.335	0.470	0.026	0.005K	0.010
73/06/22	10	10	0.300	0.520	0.115	0.005K	0.010
73/07/25	10	15	0.270	0.530	0.044	0.010	0.010
73/08/23	10	45	0.231	0.545	0.280	0.006	0.020
73/09/15	10	20	0.250	0.420	0.021	0.005K	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED

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STORET RETRIEVAL DATE 73/02/04

2261701 L2261701
45 13 00.0 085 04 00.0
PORTER CREEK
26 13 BOYNE CITY
T/LAKE CHARLEVOIA
RD XING IN ADVANCE 3 MI WNWBOYNE CITY
11EMALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/29	09	45	0.286	3.400	0.180	0.005K	0.005K
72/11/21	10	30	0.333	2.700	0.090	0.005K	0.009
72/12/20	10	00	0.390	2.450	0.115	0.006	0.012
73/01/20	10	00	0.220	0.390	0.014	0.005K	0.005K
73/02/24	10	20	0.440	0.420	0.063	0.005K	0.010
73/03/24	10	00	0.330	0.140	0.018	0.005K	0.005K
73/04/07	10	05	0.329	0.490	0.052	0.005K	0.010
73/04/21	10	00	0.273	1.100	0.024	0.009	0.040
73/05/05	10	00	0.280	0.370	0.017	0.005K	0.010
73/05/19	10	00	0.270	0.400	0.030	0.005K	0.005K
73/06/22	10	15	0.349	0.680	0.028	0.005K	0.010
73/07/25	10	00	0.340	0.240	0.021	0.010	0.025
73/08/23	10	30	0.315	1.400	0.057	0.006	0.015
73/09/19	10	25	0.330	0.480	0.021	0.006	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

2517E1 L52617E1
45 08 00.0 085 08 30.0
JORDAN RIVER
26 15 BOYNE CITY
T/LAKE CHARLEVOIX
ROGERS BRDG 1.5 MI S EAST JORDAN
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/24	14 00		0.750	0.340	0.056	0.005K	0.006
72/11/21	14 45		0.770	0.550	0.031	0.006	0.007
72/12/20	14 30		0.740	0.360	0.022	0.005K	0.014
73/01/20	09 30		0.510	0.350	0.012	0.005K	0.015
73/02/24	09 50		0.790	0.220	0.014	0.005K	0.010
73/03/24	13 30		0.740	0.160	0.031	0.005K	0.010
73/04/07	09 25		0.730	1.250	0.063	0.006	0.025
73/04/21	14 35		0.590	0.390	0.021	0.008	0.035
73/05/05	09 30		0.640	0.270	0.014	0.005K	0.015
73/05/19	14 00		0.600	0.520	0.013	0.005K	0.013
73/06/22	09 30		0.630	0.220	0.022	0.005K	0.010
73/07/25	09 30		0.700	0.300	0.015	0.011	0.011
73/08/23	10 00		0.710	1.000	0.022	0.007	0.015
73/09/13	19 40		0.720	0.340	0.008	0.006	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

2S17W1 S26N17W1
45 11 00.0 085 10 00.0
ADAMS CREEK
26 15 ROYNE CITY
1/LAKE CHARLEVOIX
ST HWY 66 XING 1.7 MI NW EAST JORDAN
11EPALES 2111204
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	NITRO GEN, AMMONIA TOTAL MG/L	NITRO GEN, NO2+NO3 TOT MGL N MG/L	NITRO GEN, ORGANIC TOTAL MG/L	ORTHO PHOS-PHATE ORTHO MG/L P	PHOS-PHORUS PHOS-TOT MG/L P
72/10/24	13 40		0.190	0.500	0.063	0.005K	0.007
72/11/21	13 30		0.230	1.750	0.072	0.005	0.014
72/12/20	13 35		0.210	0.750	0.042	0.005K	0.013
73/01/20	13 30		0.190	0.420	0.009	0.005K	0.010
73/02/24	12 40		0.200	0.430	0.015	0.005K	0.010
73/03/24	13 00		0.210	0.340	0.005K	0.005K	0.005K
73/04/07	12 45		0.170	0.420	0.011	0.005K	0.013
73/04/21	14 00		0.190	1.650	0.022	0.006	0.033
73/05/05	13 30		0.190	0.450	0.011	0.005K	0.013
73/05/14	13 30		0.180	1.230	0.029	0.005K	0.010
73/06/22	13 00		0.260	0.990	0.035	0.011	0.020
73/07/25	14 00		0.350	0.740	0.011	0.010	0.010
73/08/23	13 00		0.330	1.150	0.034	0.008	0.013
73/09/15	13 30		0.360	0.620	0.011	0.010	0.013

< VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

261701 L5261701
45 17 00.6 085 14 00.0
LOEB CREEK
26 15 BAYSHORE
1/LAKE CHARLEVOIX
ST HWY 66 XING 2.5 MI SE CHARLEVOIX
11EPALES 21112U4
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 N02&N03 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/24	13 00		0.067	1.100	0.069	0.005K	0.007
72/11/21	13 00		0.147	0.630	0.044	0.005K	0.007
72/12/20	12 30		0.154	1.200	0.050	0.005K	0.006
73/01/20	13 00		0.340	0.450	0.019	0.005K	0.010
73/02/24	12 10		0.220	0.420	0.033	0.005K	0.005K
73/03/24	13 30		0.147	0.330	0.010	0.005K	0.005K
73/04/07	12 30		0.120	1.400	0.050	0.005K	0.010
73/04/21	15 40		0.115	2.100	0.064	0.006	0.015
73/05/05	13 00		0.100	0.520	0.024	0.005K	0.010
73/05/19	13 00		0.075	1.700	0.036	0.005K	0.010
73/06/22	12 45		0.240	1.800	0.046	0.005K	0.020
73/07/25	13 00		0.294	1.150	0.028	0.011	0.017
73/08/04	12 30		0.390	1.700	0.068	0.005K	0.020
73/09/15	13 00		0.510	0.560	0.014	0.009	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

261750 P0261750 P002700
45 12 30.0 085 01 00.0
BOYNE CITY
26 15 BOYNE CITY
0/LAKE CHARLEVOIX
LAKE CHARLEVOIX
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/07/05	08 00								
CP(T)-			0.170	14.000	3.100		2.600	0.800	0.800
73/07/05	16 00								
73/08/03	07 00								
CP(T)-								0.800	0.600
73/08/03	16 00								
73/09/06	07 00								
CP(T)-				6.900		0.110		0.600	0.600
73/09/07	07 00								
73/11/04	07 00								
CP(T)-			3.400	3.200	0.039	0.250	0.680	0.450	0.500
73/11/05	07 00								
73/12/04	07 00								
CP(T)-			0.140	10.500	0.097	0.140	1.350	0.450	0.460
73/12/04	24 00								
74/02/21	08 00								
CP(T)-			0.360	8.000	0.160	0.180	1.200	0.525	0.450
74/02/21	16 00								
74/03/28	07 00								
CP(T)-			0.920	6.700	0.056K	0.130	1.080	0.625	0.650
74/03/28	14 00								
74/06/13	07 00								
CP(T)-			0.360	8.700	0.230	0.087	0.632	0.600	0.650
74/06/13	15 00								
74/07/09	07 00								
CP(T)-			0.040	8.500	2.700	1.100	2.700	1.500	0.800
74/07/09	16 00								

K VALUE KNOWN TO BE LESS
THAN INDICATED